INTERNATIONAL JOURNAL OF ACADEMIC RESEARCH IN PROGRESSIVE EDUCATION & DEVELOPMENT

OPEN ACCESS JOURNAL

Vol 12, Issue 1, (2023) E-ISSN: 2226-6348

A FUYOH-MATH Strategy via Mnemonic Technique for Engineering Mathematics Learning

Set Foong Ng, Norbaiti Tukiman and Wan Munirah Wan Mohamad

Faculty of Computer and Mathematical Sciences, Universiti Teknologi MARA, Johor Branch, Pasir Gudang Campus, 81750 Masai, Johor, Malaysia

Email: ngsetfoong061@uitm.edu.my, wanmunirah@uitm.edu.my

Corresponding Author Email: norbaiti289@uitm.edu.my

To Link this Article: http://dx.doi.org/10.6007/IJARPED/v12-i1/16136 DOI:10.6007/IJARPED/v12-i1/16136

Published Online: 06 January 2023

Abstract

This paper examines mathematics learning strategy to solve mathematics problem. Whenever engineering students are given difficult or non-routine mathematics problems, their lack of confidence or insufficient proper learning strategy are some of the factors causing them to give up easily on solving the problems. The objectives of this paper are to develop an innovative mathematics learning strategy named as FUYOH-MATH via mnemonic technique and to adopt the learning strategy in mathematics learning through examples. FUYOH-MATH was created by combining "MATHEMATICS" and a Malaysian localized slang "FUYOH" that is well-known by most people including youth in Malaysia. The FUYOH-MATH strategy is formed by mnemonic technique by taking the first letters of the four elements namely (1) F: Fundamental formula learning, (2) U: Understand formula, (3) M: Memorize formula, (4) A: Apply formula. The strategy is illustrated by two examples including learning a simple elementary Algebra topic and solving a complex Ordinary Differential Equation. The learning strategy and the examples presented in this paper could serve as a reference for other mathematics learners and educators in enhancing classroom mathematical learning. The development of this learning strategy contributes to the mathematics learning pedagogy in empowering student's mathematics learning skill.

Keywords: Mnemonic Technique, FUYOH-MATH, Mathematics Learning, Ordinary Differential Equation, Complex Mathematics Problem

Introduction

Mathematics is the foundation for various fields of study. As described by Tsue and Anyor (2006), mathematics is the language of science and technology. Mathematics symbols are employed to express the physical rules of nature while the mathematics concepts and procedures give scientists insight into the natural phenomenal world. Engineering is regarded as the application of sciences and mathematics to the design of building and project for the use of society (Flegg et al., 2012). Therefore, engineering students should master the skills in mathematics for their engineering studies as well as their future career. Engineering

mathematics covers various topics from the elementary topics in Algebra to advanced topics in Calculus. As reported in the study by Kashefi et al (2012), students usually struggle when they encounter non-routine problems in Calculus, where the problems cannot be solved by routine or standard problem-solving techniques. Students often give up easily on solving difficult or complex mathematical problems due to their lack of confidence or insufficient learning strategy.

Educator's role should not be limited to teaching new knowledge to students. Instead, guiding students with appropriate learning strategy is equally important in helping students to master mathematics skills. To enhance classroom mathematical learning, a learning strategy named as FUYOH-MATH is proposed in this paper. The name FUYOH-MATH was created by combining the word "MATHEMATICS" and a Malaysian localized slang "FUYOH" that is well-known by most people especially youth in Malaysia. The FUYOH-MATH strategy is creatively formed by using mnemonic technique. Details of the strategy are given at the methodology section.

The word "FUYOH" has the meaning of "wow", and it is used to express astonishment. Most of Malaysian undergraduates who are in their 20s would use the word "FUYOH" in their daily conversation. Using the word "FUYOH" during casual conversation would add an element of fun and a sense of localization among Malaysians. Many local advertisements have also used the word "FUYOH" in their advertising title to attract the attention of local people.

Due to the popularity and common usage of the word "FUYOH", the proposed strategy that aims in enhancing classroom mathematical learning was named as FUYOH-MATH. This is to engage the students with jargon that they are familiar with and interested in. The FUYOH-MATH strategy focuses on learning and applying fundamental formula to solve mathematics problem. The objectives of this paper are: to develop an innovative mathematics learning strategy named as FUYOH-MATH via mnemonic technique, and to adopt the learning strategy in mathematics learning through examples.

The structure of this paper is as follows: A review on the related mathematics learning is presented in the next section. The methodology section presents the formation of FUYOH-MATH strategy. In the results and discussion, a simple example on using FUYOH-MATH strategy in learning an elementary Algebra concept is first presented. Next, the FUYOH-MATH strategy is adopted in solving a complex mathematics problem, that is a first order Ordinary Differential Equation. The conclusion of this paper is presented at the last section.

Literature Review

Having a strong foundation in mathematics is crucial for undergraduate students to master useful arithmetic skills when calculations are needed to solve various problems. For students who take engineering courses, acquiring the knowledge in engineering mathematics is a must for them to excel in other subjects. As many engineering concepts cannot be comprehended without mathematics knowledge, the student's academic performance in engineering courses heavily depends on the skill in mathematics (Khiat, 2010). Hence, mathematics is part of the foundation in engineering. Lecturers who taught undergraduate engineering students often found that not all students could excel in engineering mathematics (Perante, 2022). Learning mathematics should be a fun experience for every learner (Ariadna & Natalia, 2022; Ng *et al.*, 2022; Abdullahi *et al.*, 2021; Tukiman *et al.*, 2021). With the hope of helping students to have the sense of satisfaction and happiness in learning mathematics, they should be guided on how to study mathematics in a systematic way.

Numerous studies reported findings on learning obstacles faced by students in mastering mathematics including engineering mathematics (Kashefi et al., 2012; Finesilver et

al., 2022). The learning obstacles listed in the studies are such as: students focus on routine and procedural techniques rather than conceptual understanding, confuse in the specific mathematical concepts, do not treat mathematics as a priority, lack of proper learning styles, students do not understand basic mathematics skills, do not recall knowledge fact and facing problem in solving non-routine questions.

To assist students to overcome their obstacles in learning mathematics, some researchers have used Creative Problem Solving as a framework for solving problems where it employs different thinking skills and tools. Fundamentally, it could improve students' learning in mathematics as well as other science and engineering subjects (Lumsdaine & Voitle, 1993). Five steps in Creative Problem Solving are (Kashefi et al., 2012): Step 1 - Problem definition, Step 2 - Idea generation, Step 3 - Creative idea evaluation, Step 4 - Idea judgment, Step 5 - Solution implementation.

Mnemonic technique is another learning strategy that uses the idea of developing ways to encode information for easier memorizing and retrieving it (Mastropieri & Scruggs, 1998). Drushlyak *et al* (2021) stated that mnemonic technique should be employed as a method to perceive new information by the creation of associative links using special letters, words and visual techniques. Various mnemonic methods are such as Consistent Associations Technique, Key Letters Method, and Transformation Method are used by educators. It has been shown that mnemonic technique can help students to remember a variety of mathematical information in mathematics learning (DeLashmutt, 2007; Eckler, 2008; Hunt, 2010; Lesser, 2011). Key Letters Method or First Letter Method is one of the famous mnemonic techniques that uses an associative connection that is formed by the first letters of a list of words that one need to remember. The first letters of words are then specially formed a sentence or poem that can be remembered easily. It is a learning strategy that helps students to remember and retain information by making recall easily. Some studies demonstrated the usefulness of using mnemonic technique in certain mathematics topics such as trigonometry (Hunt, 2010; Lesser, 2011), correct order of operations of algebraic operations (DeLashmutt, 2007) and number of sequences (Eckler, 2008).

Apart from the usage of mnemonic technique in mathematics learning, numerous studies have also employed the technique in other subjects. Kusumaningrum et al (2021) employed mnemonic method in developing textbook based on brain-based learning. The results showed that the learning outcome of students has increased. On the other hand, Farrokh et al (2021) examined the impact of visual mnemonic technique for English vocabulary learning. Moreover, Paivio & Desrochers (1981) reviewed various mnemonic techniques and the related issues in second-language learning. The researchers presented the limitations and strengths of imagery mnemonics for educators and students in learning second languages. It is found that the strength of the image-based mnemonic techniques emphasizes the idea of mapping a second language vocabulary onto the students' existing knowledge. The study by Jurowski et al (2015) mentioned several advantages of mnemonic techniques such as: it is effectively helping people in remembering information, retaining more information in memory and it is a procedure for intensification of memory.

Based on the review on the learning obstacles in mathematics, mnemonic technique and its applications, there is still room for improvement for educators to develop various teaching and learning strategies via mnemonic technique especially in helping students to improve their mathematics learning.

Methodology

The formation of FUYOH-MATH strategy is presented in this section. To encounter the learning obstacles that were often faced by students and referring to the fundamental of Creative Problem Solving as the basis, the FUYOH-MATH strategy is proposed in this paper. The strategy is formulated with the aim of helping students to have a systematic learning strategy in mathematics. FUYOH-MATH should be treated as the basic mathematics learning strategy. When students have a good grasp of learning strategy, their mathematics foundation will be strong. Then, they could employ Creative Problem Solving easily and confidently in solving various problems in mathematics and other engineering courses. The FUYOH-MATH strategy as shown in Figure 1 consists of four important elements.

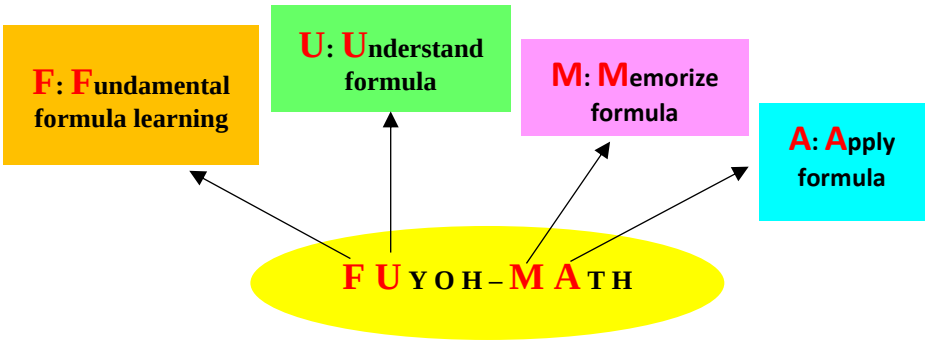

Figure 1: FUYOH-MATH strategy

Four elements in FUYOH-MATH strategy are

(1) F: Fundamental formula learning,

(2) U: Understand formula,

(3) M: Memorize formula,

(4) A: Apply formula.

The mnemonic technique that was used in the formation of FUYOH-MATH strategy is elaborated. The first letter “F” in the first element “Fundamental formula learning” and the first letter “U” in the second element “Understand formula” formed the first two letters in “FUYOH”. Then, the first letter “M” in the third element “Memorize formula” and the first letter “A” in the fourth element “Apply formula” formed the first two letters of “MATH” or “MATHEMATICS”. The combination of “FUYOH” and “MATH” formed an easy-to-remember “FUYOH-MATH” word for students to remember these four elements in mathematics learning strategy. This is by using the concept of First Letter Method in mnemonic technique. Mnemonic is a system such as a pattern of letters, ideas, or associations which assists in remembering some information.

Referring to the first element “F: Fundamental formula learning”, many fundamental formulae that are essential in solving mathematics problems should be taught to students. Students should learn sufficient fundamental formulae or theorems for them to be able to solve various mathematics problems. The second element “U: Understand formula” should be a critical strategy in mathematics learning. It is always a good practice for the students to understand why, when and how to use the formula.

The third element "M: Memorize formula" is a strategy that should not be avoided in learning mathematics. It is necessary to memorize the formula after understood the formula. Although the references such as textbooks or resources from the website are widely available, memorizing the fundamental formula is still essential. The reason is, when a certain number of fundamental formulae are stored in our memory, it is easier to identify which formula should be used in solving problem that requires multiple formulae.

The fourth element is "A: Apply formula". Correctly or creatively applying the formula that students have learned and remembered during their study would lead to the success in solving the mathematical problem. This is by using the concept of Creative Problem Solving. As recommended in the framework of Creative Problem Solving, creative idea that leads to the solution implementation would help students solving miscellaneous problems including difficult and non-routine mathematics questions. The creative idea for solving mathematics problems is always accompanied by the fundamental mathematics formula.

In this study, the FUYOH-MATH learning strategy is adopted through two examples. The implementation of the strategy is gained from the educator's perspective in guiding students to learn and solve mathematics problem. Firstly, a simple example on using FUYOH-MATH strategy in learning an elementary Algebra concept is presented. Then, the second example, that is a complex mathematics problem in the topic of first order Ordinary Differential Equation is presented.

Results and Discussion

In this section, two examples of how FUYOH-MATH strategy can be implemented in mathematical learning are demonstrated from the educator's perspective. For the first example, a simple elementary Algebra concept using FUYOH-MATH strategy in learning is first presented. Next, the FUYOH-MATH strategy is adopted in solving a complex mathematics problem, that is a first order Ordinary Differential Equation.

FUYOH-MATH strategy in learning an elementary Algebra Concept

A simple example on using FUYOH-MATH strategy in learning an Algebra concept is described in this section. The Law of Indices in Algebra consists of several important formulae that are essential in simplifying algebraic expressions. The students should first be taught and have completed the "Fundamental formula learning" as listed below:

(1) Multiplication: $x^m \times x^n = x^{m+n}$,

(2) Division: $\frac{x^m}{x^n} = x^{m-n}$,

(3) Brackets: $\left(x^m\right)^n = x^{m \times n}$,

(4) Negative power: $x^{-m} = \frac{1}{x^m}$,

(5) Power of zero: $x^0 = 1$,

(6) Fractional power: $x^{\frac{m}{n}} = \sqrt[n]{x^m}$.

For each formula, students should be explained in order to "Understand the derivation or concept of the formula". For example, to understand the formula $x^m \times x^n = x^{m+n}$, explanation is given to students to know how the formula is derived. A simple explanation that can be given is such as: $x^3 \times x^2 = (xxx)(xx) = x^5 = x^{3+2}$. The full explanation is available at https://www.learninghub.ac.nz/laws-of-indices/.

Once the students understood how the formula works, they should "Memorize the formula". This is to help them to have a pool of fundamental formulae in their memory. Later, they could creatively "Apply the formula" in miscellaneous mathematics problems related to simplification of algebraic expressions. Each element and its corresponding sequence in FUYOH-MATH strategy are important in helping students to learn mathematics better and hence have a good foundation in mathematics. This strategy could be used in learning various mathematics topics from elementary Algebra topics to advanced mathematics topics.

FUYOH-MATH strategy in solving a complex Ordinary Differential Equation

In this section, FUYOH-MATH strategy is adopted in solving a complex problem in Calculus. The problem is a first order Ordinary Differential Equation. Calculus is an important mathematics subject for students who pursue the study in engineering. Students are required to take several subjects of Calculus such as Calculus 1 and Calculus 2 in their first-year study. Calculus 1 covers basic differentiation and integration techniques while Calculus 2 covers advanced topics in integration and differential equation. Calculus 1 is the pre-requisite subject for Calculus 2.

The background of the complex problem is presented in the first sub-section "The problem". Although the first-year engineering students have learned the topic of Ordinary Differential Equation in the Calculus 2 in their second semester, the problem presented in this paper appears to be a challenge for many people including students.

In order to show that the problem can still be solved by using FUYOH-MATH strategy, the second sub-section "The fundamental formulae" presents the definitions and formulae that are needed to solve the problem. In fact, these fundamental formulae or concepts are previously learned by the students in the Calculus 1 during their undergraduate first semester or during their high school. Thus, students are encouraged to learn, understand and memorize the fundamental formulae or concepts. This is the FUYOH-MATH strategy that we would like to encourage students to implement in their mathematics learning. Then, the fundamental formulae can be creatively applied in finding the solution for the complex problem.

The third sub-section "Applying the fundamental formulae to find the solution" presents how the complex problem could be solved.

The Problem

A differential equation is defined as an equation contains an unknown function and one or more of its derivatives. The derivative can be first order derivative, second order derivative or even higher order. The order of the differential equation is the order of the highest derivatives found in the equation. Many mathematical models of real-world problems are in the form of differential equation. For examples, it could be the motion of a spring, the formation and growth of sea ice or the rate of change of infectious disease in human

population (Steward et al., 2021). The complexity of the differential equation could range from a simple form to a very complex form in real-world applications.

An example of complex first order differential equation is given in (Linder, 2019; MIT Technology Review, 2019). The differential equation is shown in the Equation (1). It is stated that the expression in the differential equation is too complex that even some powerful mathematics software packages failed to get the solution for the differential equation. Considering the number of terms and the complexity of the equation, solving this first order differential equation could be a challenge for human and software.

$$\frac{dy}{dx} = \frac{16x^3 - 42x^2 + 2x}{\sqrt{-16x^8 + 112x^7 - 204x^6 + 28x^5 - x^4 + 1}} \quad (1)$$

Due to the complexity of the Equation (1), an attempt of using online calculator to solve this equation was done. Online calculator is one of the mathematical solving tools for people who do not have strong programming background. The easy-to-use and easy-to-understand user interface in online calculator enable people to write the mathematical question as the input easily. Then, the final solution would be produced by the online calculator in a very short time.

Various mathematical software packages require users to master specific programming language. However, online calculators do not require users to key in the equation with any programming language. Hence, the widely available online calculators on websites become an alternative option for people to find the answer for mathematics problems. We have attempted to use several different online calculators to solve the differential equation as given by Equation (1). The online calculators used were Calculator Ordinary Differential Equations (MathDF), Differential Equation Calculator (eMathHelp), WolframAlpha Webpage, Ordinary Differential Equations Calculator (Symbolab), Differential Equations Calculator (Math10) and Differential Equations Calculator (SnapXam). The advantages of using online calculators to solve mathematical problems are, the final answer and the steps in deriving the solution are given by the online calculators. Some of these online calculators adopted Artificial Intelligence (AI) technology, breakthrough algorithms and knowledgebase in finding the solution.

Table 1 summarizes the results of using the online calculators to solve differential equation that is given by Equation (1).

Table 1

Results from online calculators

Online Calculator	**Result from Online Calculator**
Calculator Ordinary Differential Equations (MathDF) https://mathdf.com/dif/	Couldn't find a solution for this differential equation or a solution in elementary functions does not exist (Unable to find a solution)
Differential Equation Calculator (eMathHelp) https://www.emathhelp.net/en/calculators/differential-equations/differential-equation-calculator/	Invalid input (Unable to find a solution)
Ordinary Differential Equations Calculator (Symbolab) https://www.symbolab.com/solver/ordinary-differential-equation-calculator	Steps or Solutions are currently not supported for this problem (Unable to find a solution)
Differential Equations Calculator (Math10) https://www.math10.com/en/problem-solver/differential-equations.html	Using support from WolframAlpha (Unable to find a solution)
Differential Equations Calculator (SnapXam) https://www.snapxam.com/calculators/differential-equations-calculator	Couldn't solve this problem right now (Unable to find a solution)
WolframAlpha Webpage https://www.wolframalpha.com/	Exact solution is not given

As a result, attempting to use the online calculators as shown in Table 1 were unable to find a solution for the Equation (1). Only one online calculator (WolframAlpha Webpage) gave an answer as shown in Equation (2).

$$y(x)=\int_1^x \frac{2\xi\left(8\xi^2-21\xi+1\right)}{\sqrt{-16\xi^8+112\xi^7-204\xi^6+28\xi^5-\xi^4+1}}\,d\xi+c_1 \tag{2}$$

However, the Equation (2) involved an unsolved integral. Thus, the answer given by the online calculator in WolframAlpha Webpage is also not an exact solution for the differential equation as given by Equation (1).

Although the recent research by Lample and Charton (2019) has proposed a new neural network for Facebook that can solve complex mathematical problems, the existing mathematical software packages or online calculators have yet to incorporate the new approach or develop their new approach to solve complex mathematical problems. In this paper, we would like to share our findings on solving this complex differential equation. We developed a series of systematic and workable steps in deriving the solution for the

differential equation by using fundamental formulae or concepts. Surprisingly, these fundamental formulae are learned by many first-year engineering students in their first semester. It is hoped that the result presented in this paper could be a reference for others in mathematics learning that involve similar problem.

The Fundamental Formulae

The mathematical theorem and rules that were involved in deriving the solution for the differential equation in Equation (1) are: separable first order differential equation, Substitution Rule, Substitution Rule in reverse, integration by trigonometric substitution and squaring a polynomial. The Definition 1 to 6 are first presented (Anton et al., 2021; Steward et al., 2021; Zill & Cullen, 2009).

Definition 1. A differential equation is defined as an equation contains an unknown function and one or more of its derivatives. The order of the differential equation is the order of the highest derivatives in the equation. Specifically, first order differential equation contains only an unknown function and its first order derivative.

Definition 2. A differential equation is classified as separable first order differential equation if the first order derivative $\frac{dy}{dx}$ can be factored into a function of x, that is $p(x)$, and a function of y, that is $q(y)$, as given by

$$\frac{dy}{dx}=\frac{p(x)}{q(y)}, \tag{3}$$

where $q(y)\neq 0$.

To solve the above separable first order differential equation, rewrite it into $q(y)dy=p(x)dx$. Integrate both sides, the solution of the first order differential equation can be obtained.

Definition 3. A function is called a solution of a differential equation if the differential equation is satisfied when the function and its derivatives are substituted into the differential equation.

Definition 4. The Substitution Rule is used when an integral can be written in the form of $\int f(g(x))g'(x)dx$. If $u=g(x)$ is a differentiable function and f is continuous, then the integral can be solved by

$$\int f(g(x))g'(x)dx=\int f(u)du. \tag{4}$$

Definition 5. Trigonometric substitution $u=a\sin\theta$ is used to solve the integral that consists of the radical expression in the form of $\sqrt{a^2-u^2}$.

For example, suppose $f(u)=\frac{1}{\sqrt{a^2-u^2}}$. We let $u=g(\theta)=a\sin\theta$. The integral $\int f(u)du$ can be solved by using the Substitution Rule in reverse, that is

$$\int f(u)du=\int f(g(\theta))g'(\theta)d\theta. \tag{5}$$

The inverse substitution $u=a\sin\theta$ is possible provided that $g(\theta)=a\sin\theta$ has an inverse function, which means $g(\theta)$ is a one-to-one function. This can be accomplished if the range of θ is restricted to the interval $\left[-\frac{\pi}{2},\frac{\pi}{2}\right]$.

Definition 6. A polynomial is an expression consisting of variables and coefficients that involves only operations of addition, subtraction and multiplication. The exponentiation of variables is non-negative integer. A polynomial with a single term is called monomial. Each monomial in a polynomial is called a term. Each monomial in a polynomial with only one variable x is in the form of $a_j x^j$, where j is non-negative integer. When combining one or more monomial by addition or subtraction, a family of polynomial are obtained. For example, binomial is a polynomial with two terms, trinomial is a three-term polynomial, quadrinomial is a four-term polynomial.

Theorem 1. Let $h(x)$ be a polynomial with only a variable x. The polynomial $h(x)$ is a combination of at least two or more monomials of $a_j x^j$ by addition or subtraction, where j is non-negative integer.
Let n be the number of terms in the polynomial $h(x)$.
Let m be the number of terms in the $\left[h(x)\right]^2$.
Then $m\le n+\binom{n}{2}$, where $n\ge 2$ and $\binom{n}{2}=\frac{n!}{(n-2)!2!}$.

Applying the fundamental formulae to find the solution

To derive the solution for the differential equation as given by Equation (1), we first identify it as separable first order differential equation according to Definition 1, 2 and 3. Hence, we have the function of x, i.e. $p(x)=\frac{16x^3-42x^2+2x}{\sqrt{-16x^8+112x^7-204x^6+28x^5-x^4+1}}$, and the function of y, i.e. $q(y)=1$.

To solve the separable first order differential equation, rewrite the Equation (1) into $q(y)dy=p(x)dx$ and integrate both sides. The solution of the first order differential equation can be derived from

$$\int dy=\int\frac{16x^3-42x^2+2x}{\sqrt{-16x^8+112x^7-204x^6+28x^5-x^4+1}}dx$$

$$y=\int\frac{16x^3-42x^2+2x}{\sqrt{1-\left(16x^8-112x^7+204x^6-28x^5+x^4\right)}}dx. \quad (6)$$

From **Definition 4**, Substitution Rule is used when the integral on the right-hand side of Equation (6) can be written in the form of $\int f(g(x))g'(x)dx$. By substituting $u=g(x)$, we may use $\int f(g(x))g'(x)dx=\int f(u)du$ to solve the integral.

In Equation (6), by letting $g'(x)dx=(16x^3-42x^2+2x)dx$ and we integrate both sides, we get $g(x)=4x^4-14x^3+x^2$. We let $u=g(x)$, then we have Equation (7) and (8).

$$u=4x^4-14x^3+x^2 \tag{7}$$

$$du=(16x^3-42x^2+2x)dx \tag{8}$$

Now, the Equation (6) can be simplified to Equation (9) by **Definition 6** and **Theorem 1**.

$$y=\int \frac{16x^3-42x^2+2x}{\sqrt{1-\left(4x^4-14x^3+x^2\right)^2}}dx \tag{9}$$

By substituting Equation (7) and (8) into Equation (9), we get Equation (10).

$$y=\int \frac{1}{\sqrt{1-u^2}}du \tag{10}$$

The integral in the Equation (10) consists of the radical expression in the form of $f(u)=\frac{1}{\sqrt{a^2-u^2}}$. In this case, we have $f(u)=\frac{1}{\sqrt{1-u^2}}$. From **Definition 5**, we let $u=g(\theta)=a\sin\theta$, i.e. $u=\sin\theta$. Thus, we get $du=\cos\theta d\theta$.

The integral $\int f(u)du$ can be solved by using the Substitution Rule in reverse, that is $\int f(u)du=\int f(g(\theta))g'(\theta)d\theta$. Hence, we solve the Equation (10) as follow.

$$\begin{aligned} y&=\int \frac{1}{\sqrt{1-u^2}}du \\ &=\int \frac{1}{\sqrt{1-(\sin\theta)^2}}\cos\theta d\theta \\ &=\int \frac{1}{\sqrt{\cos^2\theta}}\cos\theta d\theta \\ &=\int 1d\theta \\ &=\theta+C \\ &=\sin^{-1}u+C \\ &=\sin^{-1}\left(4x^4-14x^3+x^2\right)+C \end{aligned} \tag{11}$$

As a result, we obtained the solution for the problem of first order Ordinary Differential Equation as given in Equation (1). The solution is $y=\sin^{-1}\left(4x^4-14x^3+x^2\right)+C$.

The derivation of the solution for the differential equation as presented above has shown that the solution of a complex mathematics problem can still be found by learning and

creatively applying the fundamental formulae, that is by encouraging students to adopt the strategy of FUYOH-MATH.

Conclusion

In this paper, an innovative mathematics learning strategy named as FUYOH-MATH was developed using mnemonic technique. It provides a systematic learning strategy for students in solving mathematics problems. The FUYOH-MATH strategy focuses on learning, understanding, memorizing and applying fundamental formula to solve mathematics problem. Hence, students should not be afraid and discouraged when facing difficult and complex mathematics question. Instead, they should be guided with appropriate learning strategy and solving skills to solve the problem.

Two examples were given in this paper to demonstrate how FUYOH-MATH strategy could be implemented in mathematical learning from the educator's perspective. The first example is a simple elementary Algebra topic. The second example is a complex first order Ordinary Differential Equation. Although Ordinary Differential Equation is part of the syllabus in the first-year engineering mathematics, many students found that the given differential equation is very complex, and it is a challenge to find the solution. Although the problem is very complex and difficult, it has been shown in this paper that the solution can be derived by using several fundamental formulae and definitions that are learned by the engineering undergraduate students in their first year or during their high school. The FUYOH-MATH strategy focuses on learning and creatively applying fundamental formula to solve mathematics problem. This has shown that by adopting each element in FUYOH-MATH strategy and its corresponding sequence, the complex and non-routine problem can be solved. Firstly, students need to learn the fundamental formula and understand it. By memorizing or keeping the formula in their memory, they have a pool of formulae available for them to apply at the right place. Many people have the misconception that learning mathematics doesn't need memorization. However, if a learner who has learned and understood the mathematics formula, without keeping it as a database in the memory, it is hard to apply the formula to solve mathematics problems. As presented in the study by Zhang, Li and Tang (2004), the researchers agreed that mathematics education in most eastern Asian countries including China emphasizes the principle of "basic knowledge and basic skills" in teaching mathematics. Another study by Kloosterman (2002) also stated that memorization is an important element in learning mathematics.

Through this paper, it is shown that FUYOH-MATH is the basic mathematics learning strategy that should be emphasized. The students would have strong mathematics foundation when they are guided with appropriate learning strategy. Thus, when they face non-routine or complex mathematics problems, they could creatively employ the fundamental formula easily and confidently in solving various problems in mathematics. This could indirectly increase their confidence and motivation in learning mathematics especially for engineering students. As supported by the study presented in Teoh *et al.* (2020), students who have high achievement in mathematics may have strong belief in problem-solving, which have positively affected their learning attitudes towards various subjects in Science, Technology, Engineering and Mathematics (STEM).

Therefore, it is hoped that other mathematics learners could benefit from the learning strategy named as FUYOH-MATH: (1) F: Fundamental formula learning, (2) U: Understand formula, (3) M: Memorize formula, (4) A: Apply formula. However, there are some limitations

in this study. Currently, the FUYOH-MATH strategy is implemented from the educator's perspective in guiding students to learn and solve mathematics problem through examples. Thus, there is still room for improvement for the researchers to conduct a future study on observing students to implement the strategy on their own in solving mathematics problem during the class.

The FUYOH-MATH strategy and the examples shown in this paper could serve as a reference for other educators and learners to apply the strategy in learning mathematics and hence solving each problem with confident. The development of this learning strategy contributes to the mathematics learning pedagogy in enhancing and empowering student's mathematics learning skill.

References

Abdullahi, M., Ayub, A. F. M., Sulaiman, T., & Manaf, U. K. A. (2021). Predicting mathematics students' continuance intention toward learning mathematics. *Asian Journal of University Education*, *17*(3), 192-202.

Anton, H., Bivens, I. C., & Davis, S. (2021). *Calculus*. John Wiley & Sons.

Ariadna, G., & Natalia, S. (2022). Mathematics can be fun. Service-Learning innovation project at the University with primary school students. *Revista Complutense de Educacion*, *33*(3), 425-434.

DeLashmutt, K. (2007). A study of the role of mnemonics in learning mathematics. *Math in the Middle Institute Partnership Action Research Project Report,* University of Nebraska – Lincoln.

Drushlyak, M. G., Semenikhina, O. V., Proshkin, V. V., & Sapozhnykov, S. V. (2021). Training pre-service mathematics teacher to use mnemonic techniques. *Journal of Physics: Conference Series*, *1840*(1), 012006.

Eckler, A. R. (2008). Mnemonics for number sequences. *Word Ways*, *41*(4), 16.

Farrokh, P., Vaezi, H., & Ghadimi, H. (2021). Visual mnemonic technique: An effective learning strategy. *GIST–Education and Learning Research Journal*, *23*, 7-32.

Finesilver, C., Healy, L., & Bauer, A. (2022). Supporting diverse approaches to meaningful mathematics: from obstacles to opportunities. In *Enabling Mathematics Learning of Struggling Students*, 157-176. Springer, Cham.

Flegg, J., Mallet, D., & Lupton, M. (2012). Students' perceptions of the relevance of mathematics in engineering. *International Journal of Mathematical Education in Science and Technology*, *43*(6), 717-732.

Hunt, N. (2010). Using mnemonics in teaching statistics. *Teaching Statistics: An International Journal for Teachers*, *32*(3), 73-75.

Jurowski, K., Jurowska, A., & Krzeczkowska, M. (2015). Comprehensive review of mnemonic devices and their applications: State of the art. *International E-Journal of Science, Medicine and Education*, *9*(3), 4-9.

Kashefi, H., Ismail, Z., & Yusof, Y. M. (2012). Engineering mathematics obstacles and improvement: A comparative study of students and lecturers perspectives through creative problem solving. *Procedia-Social and Behavioral Sciences*, *56*, 556-564.

Khiat, H. (2010). A grounded theory approach: Conceptions of understanding in engineering mathematics learning. *Qualitative Report*, *15*(6), 1459-1488.

Kloosterman, P. (2002). Beliefs about mathematics and mathematics learning in the secondary school: Measurement and implications for motivation. In *Beliefs: A hidden variable in mathematics education?* 247-269. Springer, Dordrecht.

Kusumaningrum, V., Waluyo, J., & Prihatin, J. (2021). The development of textbook based on brain-based learning (BBL) in material organization system of life for the junior high school science. *IOP Conference Series: Earth and Environmental Science*, *747*(1), 012111.

Lample, G., & Charton, F. (2019). Deep learning for symbolic mathematics. arXiv preprint arXiv:1912.01412.

Lesser, L. M. (2011). On the use of mnemonics for teaching statistics. *Model Assisted Statistics and Applications*, *6*(2), 151-160.

Linder, C. (2019). Facebook's neural net can solve this differential equation in one second. *Popular Mechanics*.

Lumsdaine, E., & Voitle, J. (1993). Introducing creativity and design into traditional engineering analysis courses. *Proceedings, ASEE Annuul Conference, Urbana, Illinois*, 843-847.

Mastropieri, M. A., & Scruggs, T. E. (1998). Enhancing school success with mnemonic strategies. *Intervention in School and Clinic*, *33*(4), 201-208.

MIT Technology Review. (2019). Facebook has a neural network that can do advanced math.

Ng, S. F., Tukiman, N., Khalid, A. K., Jabal, M. F. A., & Yunos, N. M. (2022). Creative online assignments in mathematics learning: The implementation and users' experience. *International Journal of Academic Research in Progressive Education and Development*. *11*(2), 1216 - 1234.

Paivio, A., & Desrochers, A. (1981). Mnemonic techniques in second-language learning. *Journal of Educational Psychology*, *73*(6), 780.

Perante, W. (2022). Mathematical readiness of freshmen engineering students (K-12 2020 Graduates) in eastern Visayas in the Philippines. *Asian Journal of University Education*, *18*(1), 191-204.

Steward, J., Clegg, D., & Watson, S. (2021). *Calculus*. Cengage Learning.

Teoh, S. H., Singh, P., Cheong, T. H., Nasir, N. A. M., Rasid, N. S. M., & Zainal, N. (2020). An analysis of knowledge in STEM: Solving algebraic problems. *Asian Journal of University Education*, *16*(2), 131-140.

Tsue, E. A., & Anyor, J. W. (2006). Relationship between students' achievement in secondary school mathematics and the science subjects. *Journal of Research in Curriculum and Teaching*, *1*(1), 48-54.

Tukiman, N., Ng, S. F., Khalid, A. K., Ahmad, N. I. S., Mohamed, S. (2021). Engaging in creative teaching pedagogy based on SLSTAT gamification for learning statistics. *Journal of Academia*, *9*(2), 66 - 73.

Zill, D. G., & Cullen, M. R. (2009). *Differential Equations*. Brooks/Cole, Cengage Learning.

Zhang, D., Li, S., & Tang, R. (2004). The "Two Basics": Mathematics teaching and learning in Mainland China. In *How Chinese Learn Mathematics: Perspectives from Insiders*, 189-207.